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**PASTE SPREADING APPARATUS**

**[Abstract]**

**PROBLEM TO BE SOLVED:** To make it possible to exactly set a nozzle and a  
20 substrate in a desired positional relation by detecting the deviation rate of  
the position of a paste discharge port even if this position is fluctuated by a  
nozzle exchange.

**SOLUTION:** Although the positional relation between the visual field G of an  
image recognition camera and the paste discharge port of a nozzle is  
25 determined, a deviation arises in this positional relation if there is the nozzle

exchange. Straight paste patterns P1, P2 which intersect with each other are, thereupon, plotted from the position at certain distance from the central position PC of the visual field G at a temporary substrate placed on a table. The central point of the intersected point of these paste patterns P1, P2 is so  
5 adjusted as to be aligned to the central point PC of the visual field G in accordance with the determined positional relation. The position in the visual field G of the central point at the intersected point of the paste patterns P1, P2 is determined. The positional deviation between this position and the central position PC of the visual field G is calculated. The positional  
10 relation between the substrate and the nozzle is adjusted according to this positional deviation before the start of the paste application on the substrate when there is the positional deviation.

**[Claims]**

**[Claim 1]** A paste spreading apparatus for discharging paste from a nozzle to a substrate mounted on a table, relatively transferring the nozzle and the table, and spreading the paste on the substrate in a target pattern, the paste spreading apparatus comprising: a measuring means for adopting a new nozzle by nozzle exchange, forming first and second linear paste patterns crossing each other on the substrate mounted on the table, measuring a center point of the crossing point of the first and second linear paste patterns, and deciding the measured center point as a position of a paste discharge hole of the new nozzle; a calculating means for calculating a position change of the paste discharge hole of the new nozzle from the result of the measuring means; and a position determining means for determining the position of the substrate mounted on the table in a target position on the basis of the calculating result of the calculating means in order to spread the paste in the target pattern from the paste discharge hole of the new nozzle.

**[Claim 2]** The paste spreading apparatus of claim 1, wherein the measuring means comprises a relative transferring means for relatively transferring the table on which the substrate has been mounted and the nozzle, such that the length of the first paste pattern patterned earlier can be longer than that of the second paste pattern patterned later to cross the first paste pattern and the long part can be a recording start part, when the first and second paste patterns crossing each other are spread and patterned by using a new nozzle after a nozzle exchange.

**[Claim 3]** The paste spreading apparatus of either claim 1 or 2, wherein the

position determining means is any one of a means for determining the position of the substrate mounted on the table in a target position in order to spread the paste in the target pattern, and a means for adjusting a fixed position of a substrate position determination camera for reading an  
5 arbitrary number of paste spreading points separated from each other on the substrate.

[Claim 4] The paste spreading apparatus of either claim 1 or 2, further comprising a memorizing means for memorizing information of whether the position determination of the substrate has been performed with respect to  
10 the paste discharge hole of a new nozzle after a nozzle exchange, wherein when it is determined that, on the basis of the information of the memorizing means, the position determination has not been performed, the substrate mounted on the table is position-determined in the target position by the measuring means, the calculating means and the position determining  
15 means in order to spread the paste in the target pattern from the paste discharge hole of the new nozzle.

**[Title of the Invention]**

**Paste Spreading Apparatus**

**[Detailed Description of the Invention]**

**[0001]**

5 **[Field of the Invention]** The present invention relates to a paste spreading apparatus which can discharge paste from a nozzle to a substrate mounted on a table, relatively transfer the nozzle and the table, and spread the paste on the substrate in a target pattern, and more particularly to, a paste spreading apparatus which can spread paste from a paste discharge hole in  
10 a target position, when the paste of a paste storing vessel having a nozzle fixed to its front end is exhausted and the paste storing vessel is replaced by a paste storing vessel filled with paste.

**[0002]**

**[Description of the Prior Art]** As disclosed in Japanese Laid-Open Patent  
15 Application 2-52742, resistance patterns are formed by discharging resistance paste to an insulation substrate according to a discharge patterning method for positioning a nozzle fixed to a front end of a paste storing vessel (syringe) to face a substrate mounted on a table, discharging paste from the nozzle, relatively transferring the nozzle and the table, and  
20 spreading the paste on the substrate in a target pattern.

**[0003]**

**[Problems to be Solved by the Invention]**

In general, when paste patterns are formed, paste of a paste storing vessel may be sufficiently discharged and exhausted in a patterning operation of a  
25 succeeding substrate. In this case, it is not preferable to charge the paste

in the paste storing vessel of the precise apparatus during the patterning operation. Normally, the paste storing vessel is replaced by a new paste storing vessel filled with paste after finishing the patterning operation of one substrate and before starting the patterning operation of another substrate.

5 Since the paste storing vessel and a nozzle have been formed as a single body, the nozzle is also replaced by a new one, which is called nozzle exchange.

[0004] Before or after the nozzle exchange, a position of a paste discharge hole is changed by irregularity in processing precision or adhering precision  
10 of the paste storing vessel or the nozzle. It is thus impossible to spread and pattern the paste in a target position of a succeeding substrate.

[0005] For example, when a sealing material is patterned and spread on a liquid crystal sealed substrate of a liquid crystal display, real patterns may be mistakenly positioned. When such substrates overlap with each other,  
15 some display pixels are positioned outside the real patterns. Accordingly, the display cannot normally perform a display operation.

[0006] The present invention is achieved to solve the above problems. One object of the present invention is to provide a paste spreading apparatus which can precisely spread and pattern paste by position-  
20 determining a new nozzle and a substrate in a target position, when a position of a paste discharge hole of the nozzle is changed by nozzle exchange.

[0007] Another object of the present invention is to provide a paste spreading apparatus which can precisely spread and pattern paste by  
25 automatically position-determining a nozzle and a substrate in a target

position in regard to a position change of a paste discharge hole by nozzle exchange.

[0008]

[Means for Solving the Problem] In order to achieve the aforementioned  
5 objects of the present invention, there is provided a paste spreading  
apparatus, including: a measuring means for adopting a new nozzle by  
nozzle exchange, forming first and second linear paste patterns crossing  
each other on the substrate mounted on the table, measuring a center point  
of the crossing point of the first and second linear paste patterns, and  
10 deciding the measured center point as a position of a paste discharge hole  
of the new nozzle; a calculating means for calculating a position change of  
the paste discharge hole of the new nozzle from the measurement result of  
the measuring means; and a position determining means for position-  
determining the substrate mounted on the table in a target position on the  
15 basis of the calculating result of the calculating means in order to spread  
the paste in the target pattern from the paste discharge hole of the new  
nozzle.

[0009] Preferably, the measuring means includes a relative transferring  
means for relatively transferring the table on which the substrate has been  
20 mounted and the nozzle, so that the length of the first paste pattern  
patterned earlier can be longer than that of the second paste pattern  
patterned later to cross the first paste pattern and the long part can be a  
recording start part, when the first and second paste patterns crossing each  
other are spread and patterned by using the new nozzle after nozzle  
25 exchange.

[0010] In the case that the position change of the paste discharge hole of the new nozzle is calculated after the nozzle exchange by placing a dot on the substrate by using the paste slightly discharged from the paste discharge hole and reading the dot-placed paste position by an image processing technology, it is rare that the center of the paste slightly discharged from the paste discharge hole of the new nozzle corresponds to the center of the paste discharge hole.

[0011] According to the researches of the present inventors, when the relative transferring speed of the substrate and the nozzle is set constant and the paste is spread in the same direction, paste patterns have an almost identical width to a nozzle diameter.

[0012] On the basis of the above fact, the first and second paste patterns crossing each other are formed on the substrate from the nozzle of the new paste storing vessel after the nozzle exchange, and the position of the center point of the crossing point of the paste patterns is measured by the measuring means. The measured position is read as the center position of the paste discharge hole of the new nozzle. The position change of the paste discharge hole of the new nozzle is calculated from the measuring result. The paste discharge hole can be position-determined in the target position of the substrate by correcting the position change. Therefore, the nozzle is not mistakenly positioned before/after the nozzle exchange.

[0013] In addition, when the first and second paste patterns crossing each other are spread and patterned by using the new nozzle after the nozzle exchange, the length of the first paste pattern patterned earlier is more lengthened than that of the second paste pattern patterned later to cross the



first paste pattern, and the long part becomes the recording start part. Accordingly, the paste slightly discharged from the paste discharge hole of the new nozzle patterns the recording start part. Here, the position distant from the crossing point of the first and second paste patterns that must be  
5 read as the center position of the discharge hole of the new nozzle becomes the recording start part. As a result, near the crossing point, the center line of the paste pattern corresponds to the center of the paste discharge hole of the new nozzle, and the center point of the crossing point of the first and second paste patterns completely corresponds to the center of the paste  
10 discharge hole.

[0014] In the nozzle exchange, the memorizing means memorizes the information on the mis-position of the new nozzle has been corrected. When a new substrate is mounted on the table, the apparatus automatically confirms whether the mis-position has been corrected on the basis of the  
15 information of the memorizing means. When the mis-position has not been corrected, the apparatus calculates the mis-position of the nozzle before/after nozzle exchange, adjusts the position relation between the new nozzle and the substrate, and repeats the procedure on every substrate. Accordingly, the paste patterns can be spread and patterned in the same  
20 position of each substrate.

[0015]

[Embodiment of the Invention] The preferred embodiment of the present invention will now be described with reference to the accompanying drawings.

25 [0016] Fig. 1 is a schematic perspective view illustrating a paste spreading

apparatus in accordance with the present invention. Reference numeral 1 denotes a nozzle, 2 denotes a paste storing vessel, 3 denotes an optical displacement system, 4a denotes a Z axis table, 4b denotes a camera supporting unit, 5 denotes an X axis table, 6 denotes an Y axis table, 7 denotes a substrate, 8 denotes a  $\theta$  axis table, 9 denotes a holder, 10 denotes a Z axis table supporting unit, 11a denotes an image recognition camera (substrate position determination camera), 11b denotes a lens barrel, 12 denotes a nozzle supporting member, 13 denotes a substrate adsorbing member, 14 denotes a control device, 15a denotes a Z axis motor, 15b denotes an X axis motor, 15c denotes an Y axis motor, 16 denotes a monitor, 17 denotes a keyboard, and 18 denotes an external memory device.

[0017] Referring to Fig. 1, the X axis table 5 is fixed to the holder 9, the Y axis table 6 is loaded on the X axis table 5 to be movable in the X axis direction, and the  $\theta$  axis table 8 is loaded on the Y axis table 6 to be movable in the Y axis direction. The substrate adsorbing member 13 is loaded on the  $\theta$  axis table 8, and the substrate 7 is vacuum-adsorbed by the substrate adsorbing member 13. The four edges of the substrate 7 are paralleled in the X and Y axis directions, respectively, by rotating the  $\theta$  axis table 8.

[0018] The X axis motor 15b is mounted on the X axis table 5 and the Y axis motor 15c is mounted on the Y axis table 6. The X axis motor 15b and the Y axis motor 15c are controlled and driven by the control device 14 including, for example, a microcomputer. That is, when the X axis motor 15b is driven, the substrate adsorbing member 13 of the  $\theta$  axis table 8 of the Y axis table 6 is transferred in the X axis direction, and when the Y axis motor 15c is driven, the substrate adsorbing member 13 is transferred in the Y axis

direction. Therefore, the substrate 7 can be transferred to an arbitrary position in an arbitrary direction in parallel to the holder 9 by transferring the  $\theta$  axis table 8 of the Y axis table 6 by a predetermined distance by the control device 14. In addition, the substrate 7 can be rotated in the  $\theta$  axis direction by Z axis rotation, by rotatably driving the  $\theta$  axis table 8 by the control device 14.

[0019] The Z axis table supporting unit 10 is installed on the surface of the holder 9, and the Z axis table 4a is mounted thereon. The paste storing vessel 2 having the nozzle 1 is installed on the Z axis table 4a to be movable in the Z axis direction (up/down direction). Here, the nozzle 1 is coupled to the paste storing vessel 2 having the nozzle supporting member 12 therebetween. The nozzle 1 is position-determined below the optical displacement system 3 operated as a range finder by the nozzle supporting member 12.

[0020] In this embodiment, the nozzle 1, the paste storing vessel 2, and the nozzle supporting member 12 for coupling the nozzle 1 and the paste storing vessel 2 compose a paste cartridge. The Z axis table 4a can be controlled and driven by controlling the Z axis motor 15a by the control device 14.

[0021] The paste is discharged from the paste discharge hole of the nozzle 1 to the substrate 7 by driving the Y axis table 6 or the  $\theta$  axis table 8 and pressurizing the paste storing vessel 2. Accordingly, the paste patterns are patterned on the substrate 7.

[0022] The keyboard 17 is used to input the data for indicating the shape of the paste patterns on the substrate 7 or the data for indicating the target distance between the paste discharge hole of the nozzle 1 and the surface of

the substrate 7. In addition, the external memory device 18 such as a hard disk memorizes various set values stored in the RAM of the microcomputer of the control device 14 in the power-on state of the paste spreading apparatus in preparation to the power-off state.

5 [0023] The image recognition camera 11a having the lens barrel 11b is mounted on the camera supporting unit 4b, for recognizing the position of the substrate 7 in the initial position setting of the substrate 7. The image data are supplied to the control device 14 to control each element. The monitor 16 displays the image or the input data from the keyboard 17.

10 [0024] Fig. 2 is an enlarged perspective view illustrating the paste storing vessel 2 and the optical displacement system 3 in Fig. 1. Reference numeral 12a denotes a pipe unit. Same reference numerals are used for the same elements in Figs. 1 and 2.

[0025] As shown in Fig. 2, a triangular cutting unit is formed at the lower  
15 end of the optical displacement system 3, and a light emitting element and a light receiving element (not shown) are formed in the cutting unit. The pipe unit 12a of the nozzle supporting member 12 elongated to the lower portion of the cutting unit of the optical displacement system 3 is installed at the lower end of the paste storing vessel 2. The nozzle 1 is mounted on the  
20 bottom surface of the front end of the pipe unit 12a to be positioned at the lower portion of the cutting unit of the optical displacement system 3.

[0026] The optical displacement system 3 measures the distance between the front end of the nozzle 1 and the surface of the substrate 7 according to a non-contact triangular measuring method. That is, the laser beam L  
25 emitted from the light emitting element of the optical displacement system 3

is reflected by the measured point S of the substrate 7 and received by the light receiving element of the optical displacement system 3. In this case, in order to prevent the laser beam L from being intercepted by the nozzle supporting member 12, the light emitting element and the light receiving element are installed on the other surfaces of the cutting unit. Therefore,  
5 the laser beam L is emitted and reflected in the inclined direction.

[0027] Here, the measured point S by the laser beam L and the position just below the nozzle 1 are slightly different on the substrate 7 by  $\Delta X$  and  $\Delta Y$ . The surface of the substrate 7 is even between the measured point S and the position just below the front end of the nozzle 1. Accordingly, It is possible  
10 to precisely measure the distance between the front end of the nozzle 1 and the surface of the substrate 7 therebelow by the optical displacement system 3.

[0028] In order to start the paste spreading patterning operation, the control device 14 (Fig. 1) drops the paste storing vessel 2 until the distance  
15 between the front end of the nozzle 1 and the surface of the substrate 7 reaches a designated value by driving the Z axis motor 15a on the basis of the measurement result of the optical measurement system 3. In the paste spreading patterning operation, the control device 14 spreads the paste in the target pattern by driving the X axis motor 15b or the Y axis motor 15c  
20 according to the pattern data from the keyboard 17, transferring the substrate 7 in the X and Y axis directions, and discharging the paste from the paste discharge hole of the nozzle 1 to the substrate 7. Even if the surface of the substrate 7 is uneven, since the paste storing vessel 2 is  
25 displaced in the up/down direction on the Z axis table 4a on the basis of the

measurement result of the optical measurement system 3, the target distance is maintained between the paste discharge hole of the nozzle 1 and the surface of the substrate 7, and the width or thickness of the spread paste is wholly identical in the whole patterns.

5 [0029] Preferably, the measured point S is inclined to the X and Y axes from the paste dropping point of the discharge hole of the nozzle 1, so that the measured point S cannot cross the paste patterns previously spread on the substrate 7.

[0030] Fig. 3 is a block diagram illustrating one detailed example of the  
10 control device 14 in Fig. 1. Reference numeral 14a denotes a microcomputer, 14b denotes a motor controller, 14cb denotes an X axis driver, 14cc denotes an Y axis driver, 14cd denotes an  $\theta$  axis driver, 14ca denotes a Z axis driver, 14d denotes an image processing device, 14e denotes an external interface, 15d denotes a  $\theta$  axis motor, E denotes an  
15 encoder, and PP denotes a paste pattern. Same reference numerals are used for the same elements in Figs. 1 and 3.

[0031] As illustrated in Fig. 3, the microcomputer 14a includes a main operation unit, a ROM for storing a soft processing program for patterning the paste pattern PP, a RAM for storing a processing result of the main  
20 operation unit or input data from the external interface 14e and the motor controller 14b, and an input/output unit for exchanging data with the external interface 14e and the motor controller 14b.

[0032] The data for designating the target shape of the paste pattern PP or the data for designating the target distance between the nozzle 1 and the  
25 substrate 7 are inputted through the keyboard 17, and supplied to the

microcomputer 14a through the external interface 14e. The microcomputer 14a processes the data by the main operation unit or the RAM according to the soft program used to store the data in the ROM.

[0033] The motor controller 14b is controlled by the data for designating the target shape of the paste pattern, and the X axis motor 15b, the Y axis motor 15c or the  $\theta$  axis motor 15d is rotatably driven by the x axis driver 14cb, the Y axis driver 14cc or the  $\theta$  axis driver 14cd. The encoders E are installed on the rotation axes of the motors. Thus, the rotation value (driving operation value) of each motor is sensed and fed back to the microcomputer 14a through the X axis driver 14cb, the Y axis driver 14cc, the  $\theta$  axis driver 14cd or the motor controller 14b, so that the microcomputer 14a can control the X axis motor 15b, the Y axis motor 15c or the  $\theta$  axis motor 15d to be precisely rotated by the designated rotation value. Accordingly, the paste patterns are patterned on the substrate 7.

[0034] In addition, in the paste patterning operation, the measured data of the optical displacement system 3 are converted into digital data by an A/D converter (not shown), supplied to the microcomputer 14a through the external interface 14e, and compared with the data for designating the distance between the nozzle 1 and the substrate 7. When the surface of the substrate 7 is uneven, it is sensed by the microcomputer 14a on the basis of the input data, for controlling the motor controller 14b. The Z axis motor 15a is rotatably controlled by the Z axis driver 14ca. Therefore, the paste storing vessel 2 (Fig. 1) is displaced in the up/down direction, for maintaining the constant distance between the paste discharge hole of the nozzle 1 (Fig. 2) and the surface of the substrate 7. The encoder E is also

installed on the rotation axis of the Z axis motor 15a. The rotation value of the Z axis motor 15a is fed back to the microcomputer 14a through the Z axis driver 14ca or the motor controller 14b, so that the microcomputer 14a can control the Z axis motor 15a to be precisely rotated by the designated  
5 rotation value.

[0035] The variety of data inputted through the keyboard 17, such as the paste pattern data or the nozzle exchange data, or the variety of data processed and created by the microcomputer 14a are stored in the built-in RAM of the microcomputer 14a.

10 [0036] The paste spreading patterning operation and the nozzle exchange operation of the present invention will now be explained.

[0037] As depicted in Fig. 4, when power is applied (step 100), the initial setting of the apparatus is executed (step 200).

[0038] The initial setting is executed as shown in Fig. 5.

15 [0039] That is, in Fig. 5, the paste storing vessel 2, the Y axis table 6 and the  $\theta$  axis table 8 are position-determined in the original positions (step 201). The paste pattern data, the substrate position data and the paste discharge end position data are set (steps 202 and 203). The data for the setting operation are inputted through the keyboard 17 in Fig. 1. As described  
20 above, the input data are stored in the built-in RAM of the microcomputer 14a (Fig. 3).

[0040] Still referring to Fig. 4, whether the paste storing vessel 2 has been replaced, namely, the nozzle exchange has been performed is confirmed (step 300) (the nozzle exchange will later be explained in detail in Fig. 10 in a  
25 process for forming the paste pattern of Fig. 4 (step 700)). When the nozzle



exchange has been performed, the mis-position of the nozzle 1 is measured (step 400), and the substrate 7 is mounted (step 500). When the nozzle exchange has not been performed, the routine goes directly to step 500.

[0041] The process for measuring the mis-position of the nozzle (step 400) will now be explained with reference to Figs. 1, 6 and 7.

[0042] First, a sample substrate is loaded on and adsorbed by the substrate adsorbing member 13 (steps 401 and 402). The position of the sample substrate is set so that the visual field G of the image recognition camera 11a can exist on the sample substrate (refer to Fig. 7(a)). As illustrated in Fig. 7(b), the part PA of the sample substrate mistakenly positioned from the center point PC of the visual field G in the X axis direction by a predetermined distance X1 is transferred to the position N just below the nozzle 1 (step 403). Here, P0 implies the part of the sample substrate corresponding to the center point PC of the visual field G of the image recognition camera 11a in the state of Fig. 7(a), and being transferred with the sample substrate. As shown in Fig. 7(b), when the part of the sample substrate is position-determined in the position N just below the nozzle 1, the part of the center point PC of the visual field G of the sample substrate in the state of Fig. 7(a) is indicated as the position P0.

[0043] The paste charged in the paste storing vessel 2 is discharged to the sample substrate by dropping the nozzle 1 by the Z axis motor 15a (step 404). At the same time, the sample substrate is transferred by the X axis motor 15b by a predetermined distance X in the opposite direction to the center point PC of the visual field G of the image recognition camera 11a.

As depicted in Fig. 7(c), a linear paste pattern P1 is formed in the X axis

direction (step 405).

[0044] In addition, the distance  $X$  is set longer than the  $X$  axis direction length of the visual field  $G$  of the image recognition camera 11a, which is not essential.

5 [0045] Referring to Fig. 7(d), the sample substrate is returned in the  $X$  axis direction by a predetermined distance  $X_2$ , and the position just below the nozzle 1 to the paste pattern  $P_1$  is indicated by  $PC'$ . As shown in Fig. 7(e), the sample substrate is transferred in the  $Y$  axis direction by a predetermined distance  $Y$  (step 406), the paste is discharged to the sample  
10 substrate, and the sample substrate is transferred in the opposite direction by a predetermined distance  $2xY$ . Therefore, as illustrated in Fig. 7(f), a linear paste pattern  $P_2$  is formed orthogonally to the paste pattern  $P_1$  in the position  $PC'$ , and extended in the  $Y$  axis direction by a length of  $2xY$  (step 407). The nozzle 1 is lifted (step 408).

15 [0046] The distance  $2xY$  is set longer than the  $Y$  axis direction length of the visual field  $G$  of the image recognition camera 11a, which is not essential.

[0047] The sample substrate is transferred so that the center point of the crossing point  $PC'$  of the paste patterns  $P_1$  and  $P_2$  can correspond to the center point  $PC$  of the visual field  $G$  of the image recognition camera 11a  
20 (step 409). As discussed later, the crossing point  $PC'$  of the paste patterns  $P_1$  and  $P_2$  is measured by the image recognition camera 11a (step 410). The measured data are stored in the RAM of the microcomputer 14a (Fig. 3).

[0048] Each distance in Fig. 7 has been set in advance.

[0049] Fig. 8 shows a state where the crossing point  $PC'$  of the paste  
25 patterns  $P_1$  and  $P_2$  formed on the sample substrate corresponds to the

center point PC of the visual field G of the image recognition camera 11a.  
Same reference numerals are used for the same elements in Figs. 7 and 8.

[0050] Each distance in Fig. 7 and the position relation between the center point PC of the visual field G of the image recognition camera 11a and the center of the paste discharge hole of the nozzle 1 have been provided.  
When the sample substrate is transferred from the state of Fig. 7(f) and newly positioned on the basis of the information so that the center of the crossing point PC' of the paste patterns P1 and P2 can correspond to the center point PC of the visual field G of the image recognition camera 11a as shown in Fig. 8, the center of the crossing point PC' of the paste patterns P1 and P2 corresponds to the center PC of the visual field G of the image recognition camera 11a. However, actually, the mis-position occurs.

[0051] The mis-position results from irregularity of the processing precision of the paste storing vessel 2 or the nozzle 1, irregularity of the adhering precision, or inclination of the paste slightly discharged from the paste discharge hole of the new nozzle from the center of the paste discharge hole. One reason for such inclination is the cleaning state of the paste discharge hole of the new nozzle. That is, the inclination problem can be solved by careful cleaning. However, the nozzle exchange time increases and operational efficiency decreases.

[0052] In the embodiment of the present invention, the mis-position by the latter can be overcome in a short time by the process described below.

[0053] That is, as illustrated in Fig. 8, when the linear paste pattern P1 patterned earlier is set longer than the paste pattern P2 patterned later to cross the paste pattern P1 and spread, the recording start part has an

auxiliary operation section of distance W. That is, the paste pattern P1 is set longer than the paste pattern P2 by at least the auxiliary operation section of distance W.

[0054] In this case, the paste slightly inclined and discharged from the paste discharge hole of the new nozzle after the nozzle exchange is spread and removed on the sample substrate in the auxiliary operation section of the recording start part. The paste patterns P1 and P2 have an almost identical width to the nozzle diameter after the auxiliary operation section, namely, in the visual field G of the image recognition camera 11a of Fig. 8.

The width direction center corresponds to the center of the paste discharge hole.

[0055] As described above, after the paste inclined from the paste discharge hole is removed and the paste patterns P1 and P2 are formed and set as shown in Fig. 8, the image in the visual field G is read by the image recognition camera 11a, and the image information is processed by the control device 14 (Fig. 1). Therefore, the routine goes to the process for measuring the center point of the crossing point PC' of the paste patterns P1 and P2 that is step 410 in Fig. 6.

[0056] That is, still referring to Fig. 8, an imaginary line crossing the paste patterns P1 and P2 is set in the visual field G of the image recognition camera 11a, a differential value of luminance of the image is calculated on the imaginary line, two positions having the maximum luminance variation are determined as both edges of the paste patterns P1 and P2, and the center positions are obtained on the same imaginary line and determined as width direction center points P3 to P6 of the paste patterns P1 and P2. An

imaginary line connecting the center points P3 and P4 of the paste pattern P1 and an imaginary line connecting two center points P5 and P6 of the paste pattern P2 are obtained, and the position of the crossing point of the two imaginary lines is set as the center point of the crossing point PC' of the paste patterns P1 and P2. The center point is the center position of the paste discharge hole of the nozzle 1.

[0057] Step 410 in Fig. 6 performs the above process. The mis-position of the center point of the paste discharge hole of the nozzle from the center point PC of the visual field G of the image recognition camera 11a, namely, the mis-position of the nozzle 1 is calculated by using the data of the center position of the paste discharge hole of the nozzle 1(step 411). The mis-position of the nozzle 1 is stored in the RAM of the microcomputer 14a (Fig. 3).

[0058] Finally, the sample substrate is removed from the substrate adsorbing member 13 (step 412). The process for measuring the mis-position of the nozzle in Fig. 4 (step 400) is ended.

[0059] In addition, in Fig. 8, the paste is duplicated on the crossing point PC' of the paste patterns P1 and P2, and thus the amount of the spread paste is larger in the crossing point PC' than the other part. Accordingly, the paste may run down. However, since the center position of the crossing point PC' is not calculated by processing the image of the crossing point PC', it does not cause any problem.

[0060] Even if the paste patterns P1 and P2 are intermittently spread in the crossing point PC' not to run down, the crossing point PC' is easily obtained. For example, when the paste pattern P1 is continuously spread and the

paste pattern P2 is intermittently spread in the crossing area with the paste pattern P1, because the paste pattern P2 is linearly divided, the width direction center points P5 and P6 of the paste pattern P2 can be easily calculated. As a result, the crossing point PC' with the paste pattern P1 can  
5 be easily obtained.

[0061] In step 409, the center point of the crossing point PC' of the paste patterns P1 and P2 does not have to correspond to the center point PC of the visual field G of the image recognition camera 11a. That is, when the center of the crossing point PC' of the paste patterns P1 and P2 exists in the  
10 visual field G of the image recognition camera 11a, the microcomputer 14a can recognize the movement distance. The center point of the crossing point PC' of the paste patterns P1 and P2 is transferred in the direction of the center point PC of the visual field G by using the movement distance as the deviation with the center point PC of the visual field G. The mis-  
15 position of the nozzle 1 is calculated from the center point of the crossing point PC' of the sample paste patterns P1 and P2 and the center point PC of the visual field G.

[0062] As described above, when the process of step 400 in Fig. 4 is ended, the substrate 7 (Fig. 1) on which the paste will be spread and patterned in a  
20 target pattern is loaded and adsorbed on the substrate adsorbing member 13 (step 500), and position-determined in the substrate preliminary position (step 600). The process for preliminarily position-determining the substrate will now be explained with reference to Fig. 9 by using Fig.1.

[0063] First, position determination marks of the substrate 7 loaded on the  
25 substrate adsorbing member 13 are photographed by the image recognition

camera 11a (step 601). The center position of the position determination marks in the visual field (G in Fig. 8) of the image recognition camera 11a is required by image processing (step 602). The mis-position of the center position to the center point PC of the visual field G of the image recognition camera 11a is calculated (step 603). In order to position the substrate 7 in a target spreading start position, the movement values of the X axis table 5, the Y axis table or the  $\theta$  table 8 is calculated by using the mis-position (step 604), and converted into the operation value of the X axis motor 15c or the Y axis motor 15b (step 605). The substrate 7 is transferred to a target position by moving the X axis table 5, the Y axis table 6 or the  $\theta$  axis table 8 (step 606).

[0064] Thereafter, in order to confirm whether the substrate 7 is transferred to the target position, the position determination marks are re-photographed by the image recognition camera 11a, and the center position of the position determination marks in the visual field G is measured (step 607). The mis-position of the center position of the position determination marks to the center point PC of the visual field G is calculated (step 608). Whether the mis-position exists in the allowable range is confirmed (step 609). If so, the process for preliminarily position-determining the substrate (step 600) is ended, and if not, the routine goes back to step 604 to repeat the above procedure.

[0065] In Fig. 4, when the process for preliminarily position-determining the substrate (step 600) is ended, the routine goes to the process for forming the paste pattern (step 700). The process for forming the paste pattern will now be described with reference to Fig. 10 by using Fig. 1.

[0066] The substrate 7 is transferred to the spreading start position (step 701). The position of the substrate 7 is compared and adjusted (step 702) on the basis of the process for measuring the mis-position of the nozzle 1 in Figs. 6 and 8 (step 400). It will now be explained with reference to Fig. 11.

5 [0067] First, it is confirmed whether the mis-position of the nozzle 1 calculated in step 411 of Fig. 6 and stored in the RAM of the microcomputer 14a (Fig. 3) exists in the allowable range  $\Delta X$  and  $\Delta Y$  of the mis-position of the nozzle 1 in Fig. 2 (step 702a). If the mis-position exists in the allowable range, the routine goes to a process for setting the height of the nozzle (Z axis) in step 703 in Fig. 10. If the mis-position does not exist in the allowable range, the movement value of the Y axis table 6 to the X axis table 5 for transferring the substrate 7 is calculated from the mis-position (step 702b), and the operation value is set in the motor controller 14b (Fig. 3) (step 702c).

15 [0068] Thereafter, the X axis motor 15b and the Y axis motor 15c are rotated with the X axis driver 14cb and the Y axis driver 14cc therebetween, for transferring the substrate 7 to the X axis table 5 and the Y axis table 6 in the X and Y axis directions (step 702d). Accordingly, the mis-position of the paste discharge hole of the new nozzle 1 and the target position of the  
20 substrate 7 by the nozzle exchange is overcome by transferring the substrate 7. The substrate 7 is position-determined in the target position, and the process for comparing and adjusting the position of the substrate in Fig. 10 (step 702) is ended.

[0069] Referring to Fig. 10, the height of the nozzle 1 is set (step 703).  
25 That is, the interval between the paste discharge hole of the nozzle 1 and the



substrate 7 is equalized with the thickness of the spread paste pattern. Since the substrate 7 is set in the target position by the process for preliminarily position-determining the substrate in Fig. 9 (step 600) and the process for comparing and adjusting the position of the substrate in Fig. 11  
5 (step 702), discharge of the paste is started (step 704).

[0070] The control device 14 receives the measured data from the optical displacement system 3, measures irregularity of the surface of the substrate 7 (step 705), and decides whether the measured position of the optical displacement system 3 exists on the spread paste pattern on the basis of the  
10 measured data from the optical displacement system 3 (step 706). This decision is made by whether the measured data from the optical displacement system 3 is extremely changed by crossing the paste pattern, or whether the irregularity exceeds an allowable value. When the measured position of the optical displacement system 3 is not positioned after the  
15 spread paste pattern, the correction data for transferring the nozzle 1 in the up/down direction is obtained on the basis of the measured data from the optical displacement system 3 (step 707), the height of the nozzle 1 is corrected by driving the Z axis motor 15a, and the position of the nozzle 1 in the Z axis direction is maintained as the set value (step 708).

20 [0071] However, when the measured position is deemed to pass through the paste pattern by the measured data from the optical displacement system 3, the height of the nozzle 1 is maintained identically to the height before detection of the paste pattern, and the paste pattern is continuously discharged (step 706). When the measured position passes through the  
25 small width paste pattern, irregularity of the substrate 7 is generally not

changed. So far as the height of the nozzle 1 is not changed, the discharge shape of the paste is not changed. Therefore, target paste patterns can be formed.

[0072] Whether to continuously discharge the paste or finish the paste discharge is decided by whether the set patterning operation is finished (step 709). In the paste pattern formation, whether the current position is the vertical end of the pattern on which the substrate 7 has been position-determined is confirmed (step 711). If not, the routine goes back to the process for measuring irregularity of the surface of the substrate (step 705) to repeat the above procedure. When the paste pattern is not measured, the routine goes back to the process for correcting the height of the nozzle. As described above, the paste pattern formation is carried out until the vertical end.

[0073] In the vertical end of the pattern, the nozzle 1 is lifted by driving the Z axis motor 15a, thereby finishing the process for forming the paste pattern (step 700).

[0074] Thereafter, in Fig. 4, the paste-patterned substrate 7 is disconnected from the substrate adsorbing member 13 (step 800). Whether the whole process of Fig. 4 is stopped is decided (step 900). That is, when the same paste patterns are formed on the plurality of substrates, the routine goes back to the process for deciding the nozzle exchange (step 300), and repeats the procedure to the process for disconnecting the substrate (step 800). When the same paste patterns are spread on the whole substrates, the procedure of Fig. 4 is ended.

[0075] In addition, in the process for deciding stopping in Fig. 4 (step 900),

whether the sufficient amount of paste remains in the paste storing vessel 2 is checked by the operator or decided by the microcomputer 14a on the basis of the accumulated amount of the discharged paste after exchange. If the residual amount of the paste is small, the paste storing vessel 2 is replaced by new one. The exchange is inputted through the keyboard 17 and memorized by the RAM of the microcomputer 14a. When the routine goes back to the process for deciding the nozzle exchange (step 300), the existence/absence of the flag of the data table relating to nozzle exchange is confirmed in the RAM of the microcomputer 14a. Accordingly, the deviation can be automatically calculated in the succeeding process for measuring the mis-position of the nozzle (step 400).

[0076] After the existence/absence of the flag of the data table relating to the nozzle exchange is confirmed in the RAM of the microcomputer 14a and the deviation is automatically required in the process for measuring the mis-position of the nozzle (step 400), the flag of the data table relating to the nozzle exchange is erased in the RAM. Therefore, the process for measuring the mis-position of the nozzle (step 400) is not re-executed by the flag.

[0077] In the process for forming the paste pattern in Fig. 10 (step 700), when the nozzle exchange is performed due to lack of the paste of the paste storing vessel 2, if the routine goes to the process for disconnecting the substrate in Fig. 4 (step 800) in the exchange time, or if the paste patterns are spread and patterned on the substrate without replacement, the process for deciding the nozzle exchange (step 300) and the process for measuring the mis-position of the nozzle in Fig. 4 (step 400) are preferably performed

before the process for forming the paste pattern (step 700).

[0078] In the process for comparing and adjusting the position of the substrate in Fig. 11, when the mis-position of the nozzle 1 exists within the allowable range  $\Delta X$  and  $\Delta Y$  of the mis-position of the nozzle 1 in Fig. 2, the substrate 7 is transferred. In Fig. 1, instead of transferring the substrate 7 by installing the camera supporting unit 4b to be adjusted and transferred in the X axis direction to the Z axis table supporting unit 10, the mis-position of the nozzle 1 can be included in the allowable range  $\Delta X$  and  $\Delta Y$  by moving the image recognition camera 11a.

10 [0079] In the above embodiment, the substrate 7 is transferred in the X and Y axis directions to the paste storing vessel 2. However, it is also possible to fix the substrate 7 and transfer the paste storing vessel 2 in the X and Y axis directions.

[0080] In order to reduce the consumed time of the process for executing the initial setting of the spreading apparatus in Fig. 5 (step 200), a read and memory device for the external memory device 18 (Fig. 3) such as an IC card floppy disk or a hard disk is connected to the external interface 14e (Fig. 3). On the other hand, the data for the process for executing the initial setting of the spreading apparatus are set in advance by a personal computer, etc.. In the initial setting of the spreading apparatus, the data can be transmitted offline from the external memory device 18 to the RAM of the microcomputer 14a (Fig. 3) through the read and memory device connected to the external interface 14e.

[0081] Other changes and modifications can be made by combinations.

25 [0082]

**[Effect of the Invention]** As discussed earlier, in accordance with the present invention, although the position of the paste discharge hole to the substrate is changed by the nozzle exchange, the nozzle and the substrate can be position-determined in target positions, and the paste patterns can  
5 be precisely spread and patterned.

**[Description of Drawings]**

**[Fig. 1]** is a schematic perspective view illustrating a paste spreading apparatus in accordance with the present invention.

**[Fig. 2]** is an enlarged perspective view illustrating a paste storing vessel  
10 and an optical range finder in Fig. 1.

**[Fig. 3]** is a block diagram illustrating one detailed example of a control device in Fig. 1.

**[Fig. 4]** is a flowchart showing the whole operation of the paste spreading apparatus in Fig. 1.

15 **[Fig. 5]** is a flowchart showing a process for executing spreading initial setting in Fig. 4.

**[Fig. 6]** is a flowchart showing a process for measuring mis-position of a nozzle in Fig. 4.

**[Fig. 7]** is an exemplary view illustrating a patterning operation of two linear  
20 paste patterns crossing each other in Fig. 6.

**[Fig. 8]** is an explanatory view illustrating a method for calculating a difference between a center point of a crossing point of two paste patterns crossing each other and a center point of a visual field of an image recognition camera in Fig. 6.

25 **[Fig. 9]** is a flowchart showing a process for preliminarily position-

determining a substrate in Fig. 4.

[Fig. 10] is a flowchart showing a process for forming a paste pattern in Fig. 4.

[Fig. 11] is a flowchart showing a process for comparing and adjusting a position of a substrate in Fig. 10.

[Explanation of Reference Numerals] 1 nozzle, 2 paste storing vessel, 3 optical range finder, 4a Z axis table, 4b camera supporting unit, 5 X-axis table, 6 Y axis table, 7 substrate, 8  $\theta$  axis table, 9 holder, 10 Z axis table supporting unit, 11a image recognition camera, 11b lens barrel, 12 nozzle supporting member, 13 adsorbing member, 14 control device, 15a to 15d servo motors, 16 monitor, 17 keyboard, 18 external memory device.